On The Forefront: June 2000

by Phil Zarrow

"Lead Free - Act, Don't React"

"Good and bad, I define these terms. Quite clear, no doubt, somehow."
Bob Dylan

From time to time, in SMT, there arise issues of widespread proportions, usually in the form of calamities. I call these "buzz issues" and past ones have included cracked capacitors, the banning of freon, micro-cracking of ICs, etc. Of course, the current buzz issue is no-lead solder and material finishes. This is no small matter, but rather one of major proportions since it affects the entire industry. Unfortunately, it is generating a bit of mass-hysteria.

I discussed the basics of the matter in the August issue ("Lead Free - Don't Fight a Fact, Deal With It")[1] and it seems to be the second part that we're having trouble with. Everywhere I go within the industry, the question inevitably arises as to what I think about the upcoming potential ban on circuit boards containing lead solder and finishes (or something to that effect) and how will they ever be able to market their product in Europe if a non-leaded substitute is not found. The discussion usually goes on as to the plausibility of banning lead from circuit boards since our usage is so little compared to, say, auto batteries. Well, let's take a look around here and ascertain the facts of the Lead-free "direction".

The whole idea behind banning lead from circuit boards is the fear of the lead of discarded circuit boards leaching into the water table. Now, the electronics industry accounts for only 2% of lead usage so we do indeed wonder why they are picking on us. When was the last time you saw a discarded circuit board lying on the side of a road or in a stream? One tends to see a lot more old car batteries carelessly strewn about the landscape. Also, bear in mind that lead exists in nature *naturally* - it is not a manmade compound. Now assume, for a moment, that we now have a "lead-free" circuit board discarded safely in the landfill. How about the tin - it won't be too healthy when it leaches into the water supply. And is what about that gallium arsenide (GaAS) device on that board? I know, don't give "them" ideas.

The WEEE proposal appears to seek to first "prevent" the use of lead in products, if possible, but if that is not feasible, it pushes for recycling:

"Components containing substances listed below [lead] have to be removed from any end of life electrical or electronic equipment which is destined for landfilling, incineration, or recovery."[2]

Doesn't quite sound like an outright "ban" on lead, however, certain political types have deemed anything with lead solder in it as un-removable and thus dangerous. Interestingly,

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[1] "*On The Forefront*", Circuits Assembly, August 1999

[2] From "Proposal for a Directive on Waste From Electrical and Electronic Equipment", Annex IV, 2nd Draft. This can be downloaded from the IPC "Legislation" page at www.IPC.org.

the automotive industry has requested and is being considered for exemption and wants to be able to use lead in its products (as in batteries, perhaps?). Military electronics would also be exempted from the proposed lead ban. What, no ecologically correct weapons of mass destruction? There are some other interesting politics involved here and that seems to be the real nature of the directives. Though the date of the proposed ban keeps getting pushed back (it is now out to 2006), the possibility is very real. On the other hand, has anyone touched a real Eurodollar yet?

Logically if you can "get the lead out" of the product, it theoretically could be disposed of legally. Of course, how exactly does one reclaim lead from a PCBA? As Ralph Woodgate mentioned[3] one such method is a process that was developed and implemented in Germany that accomplishes this. Old PCBAs are ground up and the organics are removed leaving the metal(s) for recycling. No doubt there are other practical and economical methods that are also effective. One would reason (key word here being *reason*) would seem to satisfy the edicts of the EEC 75/422 Directive. Such removal would apparently be the responsibility of the original manufacturer. That manufacturer, in keeping with today's outsourcing trend, could turn to a third-party firm to specifically handle reclamation, recycling and disposal of their product. Sounds like a potential new cottage industry could evolve from this.

In the meantime, the drive continues to find a suitable no-lead alloy for use in solder as well as component and PCB finishes. The National Electronics Manufacturing Initiative (NEMI) formed a Lead-Free Task Force to come up with a recommendation for a standard lead free solder alternative. These people are very serious - the member companies pay big bucks to belong to NEMI and finance this research. Unfortunately, the best they've been able to come up is Sn95.5Ag3.9Cu0.6 for reflow and Sn99.3Cu0.7 for wave soldering. The problem here is a melting temperature of approximately 217 deg. C which means a full liquidus temperature of around 230 deg. C. Tell that to most component manufacturers and they respond with "no way" (sometimes with an expletive inserted in the middle of the statement).

The recommendation for these alloys as "standard" came from exhaustive and important research in which quite a number of alloys were researched and characterized in terms of their inter-reaction with other PCB materials, reliability aspects and relative cost.

It should be noted that the NEMI task group recommended avoiding consideration of those alloys that were subject to patents, such as Castin (among several others) which is a quartenary alloy comprised of tin-silver-copper and antimony. There is supposedly concern about control of quartenary alloys but perhaps Castin and these other alloys might be just right for some applications and thus should be thoroughly characterized on its performance just as any other alloy should.

Let's stop for a moment and ponder something. What is the "standard" alloy of the industry right now? Answer…anyone…? Yes, you in the back. Sn63Pb37 ? Well, yes, a lot of people use it but it isn't the "standard". Quite a few of you use 2% silver, as well as Sn60Pb40, Sn42Bi58 and I even came across someone using that Castin stuff. The answer is

[3] "Letters to the Editor", Circuits Assembly, February, 2000

that there is no "standard" alloy and there never was. So why, all of a sudden, do we need a "standard" alloy - no-lead or otherwise?

Let's get real. Just like most everything else in SMT, the choice of an alloy has been, and will be application driven. With the advent of the aforementioned Euro-legislation***, the alloy and the disposal scheme should be driven by the application***. Consider this practical scenario:

- Consumer electronic products, the type that are considered "throw-away consumables" with relatively short lifespans, such as portable CD and tape players, televisions, radios, and even some automotive applications - the type of things that might actually wind up in a landfill [4] would likely benefit from being constructed with no-lead alloys. The recovery process might cost too much in light of margins and the user may not be "responsible" enough to comply with such a program.

- Industrial and high-reliability applications, such as broadband and network control cards, computers, medical and military products, in fact most Class II and Class III, might still use lead bearing solder alloys and, accordingly, have reclamation programs as described. Since these products are more expensive, adding in another 5% or so for reclamation (if even that much) will not severely impact the overall cost of the product.

Of those products, in any reliability class, that want to go lead-free, there should be and are a number of options available to them - again with the application with its composition, life expectancy and operating environment driving the choice. Bismuth, when added in small percentages to tin-silver, reduces the melting point. While found to contribute to fillet lifting in through-hole joints, this seems to be the case with lead alloy finished circuit boards, as opposed to lead-free finish PCBs. It might also be ideal in surface mount joints, particularly in applications that are subjected to a high degree of thermal cycling.

I know of applications, including a large-frame computer motherboard, that were assembled with Sn42Bi58. They all operated at a relatively low, steady-state temperature and the alloy never presented reliability problems. Again, the material choice fit the application parameters.

Conductive epoxies are another alternative. Already in use in many applications, they do tend to be expensive - a silver-filled conductive epoxy is around 10 times the cost (per gram) as Sn63Pb37 solder paste. However, besides being no-lead, it is also no-clean and has some properties that make it ideal for some applications (and less than desirable for others).

The idea of a single lead-free alloy that will globally adaptable by the industry is quixotic. Accept the fact that there is not a "one size fits all" solution. Rather than try to derive a "standard alloy for the industry", the NEMI task group should use its resources to continue its valuable work in characterizing all the alloys and materials available, including their limitations and inter-reactions with other materials, so that the manufacturer might

[4] Or on the side of the road in Texas or elsewhere

choose the best solution for his application and situation, rather than be forced into conforming to a committee derived "standard".

Recycling and reclamation should be a viable direction. Instead of developing and trashing a better class of waste products, as Ken Gilleo so aptly put it[5], let's recycle what we have. This is so basic and obvious, it has to even make sense to legislators, even if they are lawyers. Let's not cower in the shadow of impractical and unnecessary legislation. Remember, we're all in this together.

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[5] "Letters to the Editor", Circuits Assembly, February, 2000